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Effect of Starch and Honey Coating on the Shelf Life of Pomegranate Arils in Refrigerated Condition

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ABSTRACT

Pomegranate arils are rich in nutrients and various phyto-chemical compounds viz. anthocyanins and hydrolysable tannins. Browning is the major physiological disorder that affects the sensory properties of minimally processed pomegranate which may be addressed by edible coating that enables addition of several active ingredients in to polymer matrix and consumed with the food, thus enhancing the safety or even nutritional and sensory attributes. The present study is to investigate the effect of honey and starch coating on the shelf life of pomegranate arils packed in PP and LDPE under refrigerated condition. Ripened arils were treated with honey of 10%, 20% and 30% in 1% cassava starch solution for 15 minutes. A total of 20g of treated arils was transferred to packaging material having a capacity of 100g. Three samples were analyzed for each treatment after 0, 4, 8, 12, 16, 20 and 24 days for firmness, colour, TSS and microbial load. The arils kept at room temperature got only a shelf life of 3 days and 4 days where as arils kept at 5°C is having 16 days and 20 days for PP and LDPE respectively. Studies shows that the maximum concentration of honey used can be 30%. Bright, rigid and extension of shelf life was found in the low concentrated (10%) honey treated samples.

KEYWORDS: *Pomegranate arils, Honey, Starch*

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1. INTRODUCTION

Pomegranate (*Punica granatum*) is a fruit bearing shrub or a small tree growing between 5 to 8m tall, mainly cultivated in Middle East, Mediterranean, China, India, U.S.A. and Mexico. This fruit is filled with seeds surrounded by pulp, called arils which is yellow to deep red in colour that contain almost 80% juice and 20% edible seed *(Ozgen et al. 2008).* The arils are rich in nutrients and various phyto-chemical compounds viz., anthocyanins and hydrolysable tannins *(Lansky and Newman, 2007; Lopez-Rubira et al., 2005; Gil et al., 2000).*

Pomegranate fruit maturity is assessed by its external colour, juice colour and acidity of juice *(Cristosto et al., 2000).* Acceptability of pomegranate by the consumers depends on different quality attributes like physico-chemical properties and mechanical properties like skin colour, free from physical damages, acidity, sugar content and flavour. Ready-to-eat pomegranate arils offer an appealing product compared to the whole fruit and increases the prospect of production and consumption *(Caleb et al., 2012).* Packaging plays an important role in maintaining the nutritional quality of fresh or fresh-cut produce *(Mditshwa et al., 2013).* Modified atmosphere packaging (MAP) has been explained to extend the shelf life of minimally processed fresh arils *(Artes et al., 1995; Gil et al., 1996a, b; Villaescusa el al, 2000).* The post-harvest shelf-life of MA-packaged arils was shown to be limited to 10 days due to fungal growth, and only 7 days when taking into account data for flavor and aroma *(Caleb et al., 2013).* Browning is the major physiological disorder that affects the sensory properties of minimally processed pomegranate *(Ergun and Ergun, 2009).* There are new disinfection methods applied as alternatives or combined with conventional use of chlorine, in the minimal processing of fresh fruit and vegetables. The alternative to the use of chemicals (preservatives) by natural materials such as starch and honey on arils has been an ongoing interest due to health benefits as well as food safety concern *(Oz & Ulukanli 2012; Xu et al. 2007).*

An edible coating is a thin film prepared from edible material that acts as a barrier to the external elements (factors like moisture, oil and vapor) and thus protects the product and extends its shelf life. Examples of some food coatings are wax for fresh fruits and vegetables, shellac coatings on candies and nuts, natural casings on meat products, and gelatin capsules for pharmaceuticals. Proteins, lipids and polysaccharides are the main constituent of edible films and coatings. Their presence and abundance determines the barrier properties of the material with regard to water vapor, oxygen, carbon dioxide and lipid transfer in food systems. Edible coating enables addition of several active ingredients in to polymer matrix and consumed with the food, thus enhancing the safety or even nutritional and sensory attributes *(Dhall, 2013).*

Honey has been used since ancient times as a sweetening agent in food *(FAO, 1996).* Diluted honey solutions prevent browning in fruits and vegetables *(Chen et al., 2000),* like fresh-cut apples *(Jeon and Zhao, 2005)*, fresh-cut pear *(Lin et al., 2008),* fresh-cut carrot *(Ergun and Koseturkmen, 2008)* and raisin *(McLellan et al., 1995).* Honey contains a number of components, which act as preservatives, such as a-tocopherol, ascorbic acid, flavonoids, other phenolics, and enzymes *(Crane, 1975; Ferreres et al., 1993).* Keeping this in mind the present study objective is to investigate the effect of honey and starch coating on the shelf life of pomegranate arils packed in PP and LDPE under refrigerated condition and to study the respiration rate of arils coated with honey in different combinations and compare with control.

2. Materials and Methods

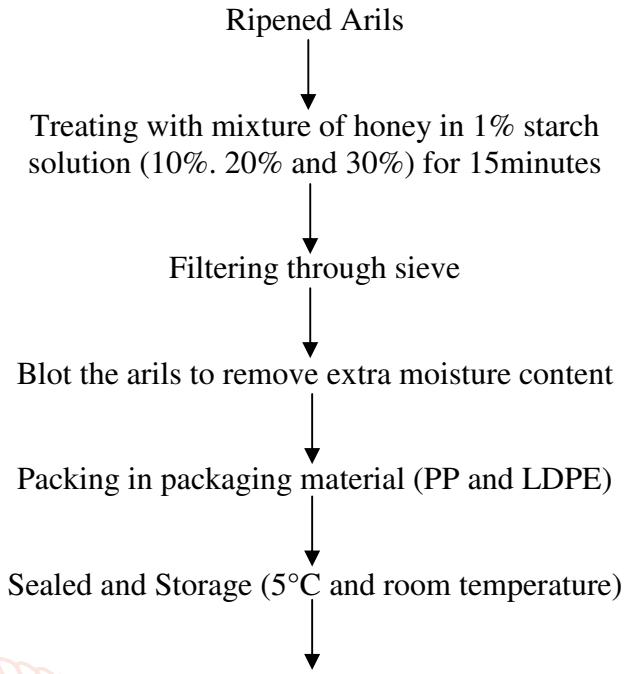
2.1. Materials

Pomegranate fruit at commercial stage of maturity was procured from the local market in Thanjavur, Tamil Nadu. Fruit were sorted out to have uniform quality and washed in chlorinated water for two minutes for disinfection. Arils were separated manually and clean by distilled water for 5 minutes in sterile sieves. Excess water was dripped off and tempered for 30 minutes at room temperature before coating.

Honey and packaging materials (Poly Propylene (PP) and Low Density Poly Ethylene (LDPE)) was procured from stores in Thanjavur, Tamil Nadu. PP and LDPE is having a guage thickness of 0.02mm and 0.1mm respectively.

2.2. Experimental design

Procedure flow chart



Ripened arils were taken and it was then treated with honey and starch solution for 15 minutes. The coating solution was prepared by mixing food-grade starch (cassava) powder (1%) and honey in the ratio 10%, 20% and 30%. The starch mixture (1%) was heated at 70°C for gelatinization. Preliminary studies were done to set the concentration of the honey and starch by aroma and taste at various concentrations. Each combination were made and coated separately. The coated sample were filtered through sieves and blotted separately for removing the extra moisture content. Then it was packed in different packaging materials. A total of 20g of arils was transferred to each packaging material having a capacity of 100g. Three samples were analyzed for each treatment after 0, 4, 8, 12, 16, 20 and 24 days for firmness, colour, TSS and microbial load.

2.3. Determination of quality attributes of pomegranate arils

2.3.1. Color Value

Colour of different samples was found out by using Hunter colorimeter (Model: colorflex EZ). Colorimeter was calibrated with a white and black standard tiles supplied by the manufacturer. Samples of arils were filled in sample holder was used to determine L, a, b values.

2.3.2. Fruit firmness

Soft arils were counted in room temperature and results were expressed as percentage. Soft arils were determined by using an index finger and thumb to very gently squeeze *(Ergun and Ergun, 2009).*

2.3.3. Total Soluble Solids

The total soluble solids (TSS) content (%) of juice was measured with a handheld refractometer *(Oz & Ulukanli, 2014).*

2.3.4. Respiration studies

The respiration rate (RR) was determined by the Gas Stream Method *(Oz & Ulukanli, 2014),* placing arils into gas-tight glass jar at 5 °C in continuous flow of humidified air (above 90% RH) free of CO2. The increase in CO2 content in the head space over a fixed period of lime was measured. Results were expressed as mL CO2/kg/h. The CO2 and O2 concentrations in the headspace gases within sealed bottles were determined with a portable handheld gas analyzer (model: PBI Dansensor). A sample of head space gas was taken from each bottle with a calibrated syringe.

2.3.5. Microbial analysis

Standard method was used to enumerate the microorganisms present in the arils. About 5g of arils were weighed and homogenized for 2 min with sterile water in mortar and pestle. Serial dilution was performed before pour plate method to determine the aerobic mesophilic microorganisms. Aliquot of 1mL was poured to petri dish, which contain 15mL of plate count agar and was mixed in a clockwise direction. The plates were allowed to solidify and kept in incubator at 30°C for 72hrs. The colonies were later counted and recorded as log cfu/g.

2.4. Statistical analysis

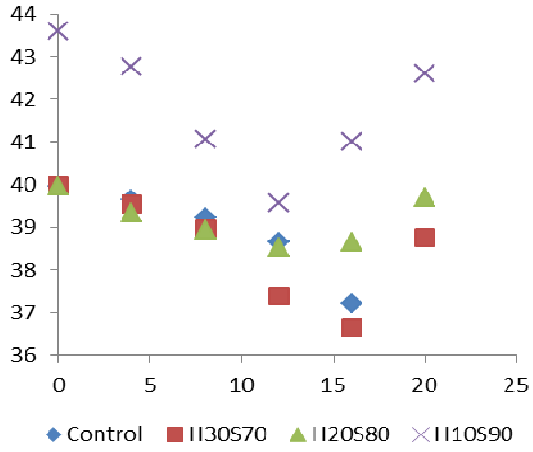
Statistical analysis of the significant differences in the colour, soft aril ratio and TSS were performed using the one factor design (Design Expert 6.0.8).

3. Results and Discussions

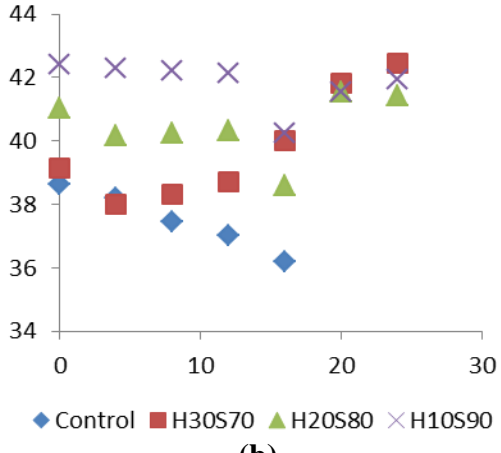
3.1. Colour of arils during storage in different packaging materials

The L values (lightness values) of treated and control sample during storage at 5°C is shown in Fig. 1. The lightness values ranged from 43.6±0.7 to 42.61±0.5 for 10% honey treatment during storage. The corresponding values of L for 20% and 30% of coated samples varied from 39.95± 0.2 to 39.71±0.07 and 39.98±0.5 to 38.77±0.4 during the 20 days of storage in PP. Similarly the lightness values of samples coated with the 10%, 20% and 30% honey kept in LDPE were ranging from 42.42±0.09 to 39.54±0.7, 41.03±0.6 to 41.41±0.1 and 39.15±0.03 to 42.47±0.5 respectively after storing for 24 days. It was found that L values of treated samples decreased till 12th day and then increased again till 20 and 24 days of storage in PP and in LDPE respectively. Similar results were observed by *Oz & Ulukanli, 2014*. This might be due to the browning of arils during the storage period. Browning rate was substantially lower in berries immersed in honey solution *(Sabir et al., 2011).*

Similarly the redness values of the treated and control samples are shown in Fig. 2. The a values of the 10%, 20% and 30% of coated samples stored for 20 days in PP were ranging from 11.06±0.17 to 14.84±0.08, 11.56±0.8 to 15.29±0.4 and 13.2±0.7 to 16.11±0.4 respectively. Similarly the samples coated with the 10%, 20% and 30% honey kept in LDPE were having redness values ranging from 12.24±0.04 to 14.53±0.1, 12.08±0.5 to 15.03±0.6 and 14.59±0.1 to 16.03±0.9 respectively after storing for 24 days. Previous studies show that redness values of arils were range from 14.2-15.2 *(O'Grady et al., 2014).* The results show that there is an increase in a-values by the increase in the days of storage. A continuous decrease was observed in control kept in PP and LDPE, the reverse trend was found in treated arils after 20 and 24 days of storage. *Bchir et al., 2012* states that redness values of arils slightly increase during storage and this increase corresponds to the increase in fruit browning. *Kapetanakou et al., 2015* reported that redness values were maintained in arils kept in PP at 4°C. From the observation during storage, when water from the arils started oozing out the redness value increased. Water loss was more in the 30% honey coated sample.



(a)



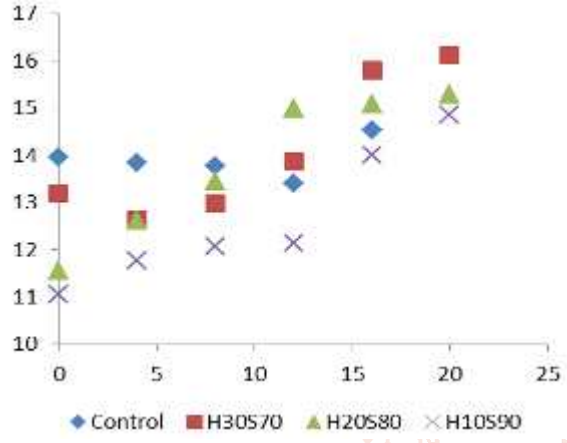
(b)

Fig 1: Lightness values of arils packed in (a) PP and (b) LDPE

There was significant difference (P<0.05) in the colour values of control sample (untreated) and the coated arils (treated) throughout the storage period.

3.2. Fruit Firmness of arils during storage in different packaging materials

Soft arils were counted at room temperature. Irrespective of treatments, soft aril ratio was increasing in all samples during the storage period and is shown in Fig. 3 and 4. 10, 20 and 30% honey + starch treatments maintained statistically (P<0.05) lower rates of softening than control samples in both PP and LDPE during storage at 5°C. At the end of 20th day arils kept in PP shows an increase of 26, 30, 34% in soft aril ratio for 10, 20 and 30% honey coated samples respectively. Whereas samples kept in LDPE gave 26, 28 and 30%. Similar trend was reported by *Ergun and Ergun, 2009* in their studies.



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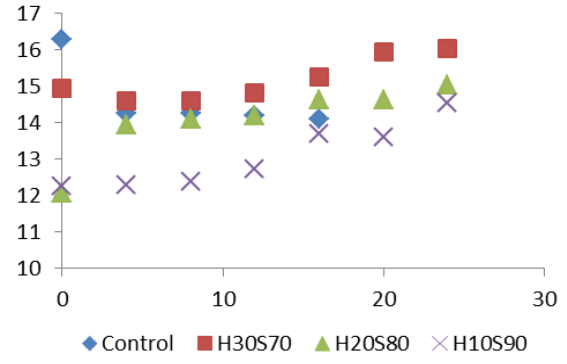


(b)

Fig 2: Red values of arils packed in (a) PP and (b) LDPE

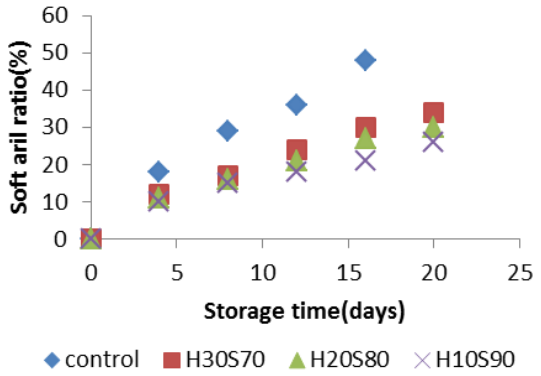


Fig 3: Soft aril ratio of arils in PP

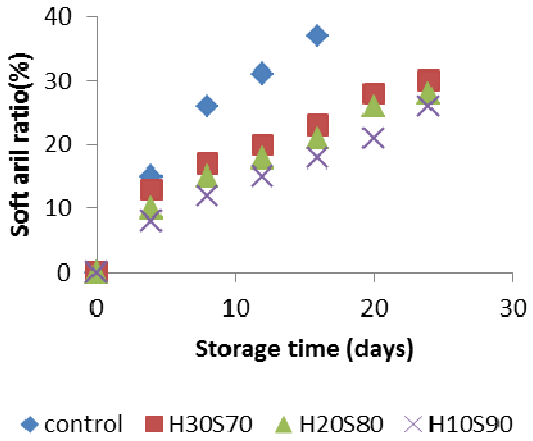


Fig 4: Soft aril ratio of arils in LDPE

The preservative characteristic and osmotic effect of honey helps in delaying the softening of arils than control samples by protecting its internal structure. The most effective treatments for preserving the fruit quality were obtained by 10% of honey + starch coating, followed by 20 and 30% honey coating itself and control in both packaging materials.

3.3. Total Soluble Solids content of arils during storage in different packaging materials

Total Soluble Solids Contents were measured at room temperature. All coating treatments were having less total soluble solids content than control sample which is shown in Fig. 5 and 6. TSS content of the samples was ranging from 17.4 to 17.8% throughout the storage. The highest TSS content was obtained by 30% of honey + starch coating, followed by 20 and 10% honey coating itself and control in both packaging materials. The TSS revealed a significant ($p<0.05$) increase in the control in both PP and LDPE group during storage at 5°C. *Ergun and Ergun, 2009* states that the soluble solid contents of arils increase slightly according to the increase in the concentration of honey. The change in the TSS content shows that the soluble solids leaks from arils to the diluted honey solution during treatment application.

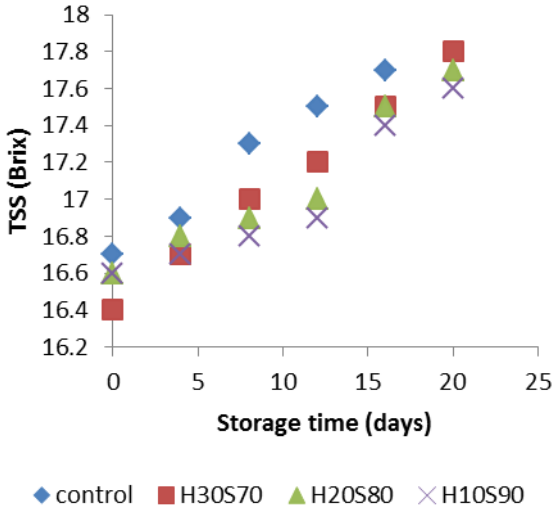


Fig 5: TSS content of arils in PP

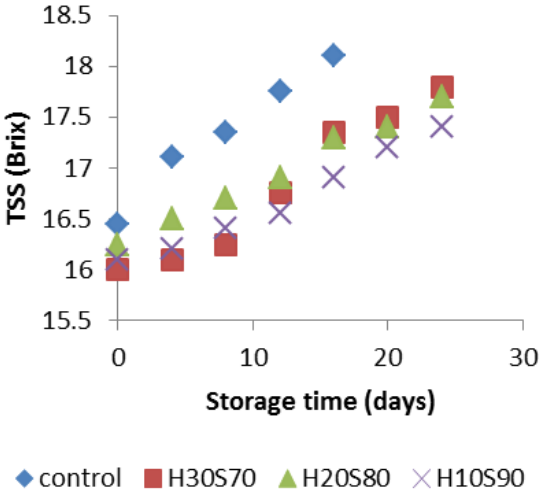


Fig 6: TSS content of arils in LDPE

3.4. Effect of coating on respiration

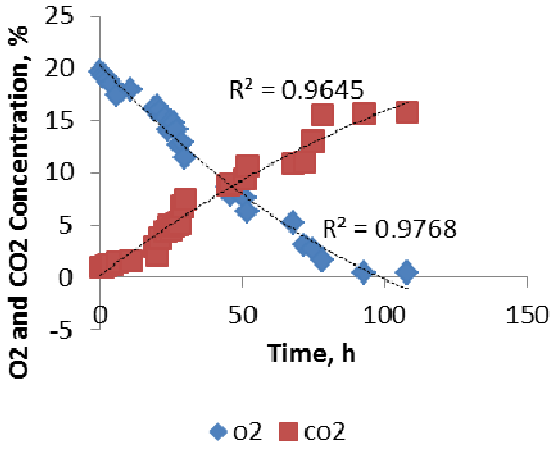
Results of respiration studies clearly show that the oxygen concentration was significantly decreasing as the time of storage in hrs increases (Fig. 7). The oxygen level got decreases to very low level in control sample first, then in 10%, 20% and in 30%. 30% honey coated sample took 160 hours for reaching the low O_2 concentration but 20% and 10% took 157 and 118 hrs respectively. Similarly the concentration of carbon dioxide respiration studies clearly show that the CO_2 concentration was significantly increasing as the time of storage in hrs increases (Fig. 7). The carbon dioxide level got increased to very high level in control sample first then in 10%, 20% and in 30%. *Guillen et al., 2013* suggests that all treatments inhibits respiration rate during storage. Their studies shows that arils coated with 100% aloe vera gel highly inhibits the respiration rate than less concentration of aloe vera gel. Present study shows that when the concentration of coating increases the respiration rate decreases which helps the arils to increase in the shelf life.

3.5. Effect of coating on microbial analysis

Microbial counts of coated and uncoated samples kept in LDPE were significantly increased during the storage at 5°C and is shown in Fig. 8. Initial microbial count was ranging from 3.2 - 3.9 log cfu/g. Total microbial count of control sample was 6.38 log cfu/g after 8 days and 6.83, 6.96 and 6.52 log cfu/g for 10, 20 and 30% honey + starch coated samples at 12, 16 and 20 days of storage. According to *Violeta et al., 2005* the maximum limit of aerobic microorganism is 7 log cfu/g. Taking this to account 30% honey + starch coated samples were having 20 days shelf life and uncoated sample is having the less. 10% and 20% were having 12 and 16 respectively. Figure 8 shows that increasing in the concentration of honey + starch coating is having a great impact in reducing the microbial load and followed by increasing the shelf life. *Ergun and Ergun (2009)* reported that honey treatment greatly delays the development of aerobic microbial count in pomegranate arils. *Lin et al. (2006)* strongly confirm that honey can delay microbial spoilage development. Starch based edible coating can act as antimicrobial agent and also inhibit the growth of yeast and mould *(Oz & Ulukanli, 2014).*

4. Conclusions

From the results, honey with starch coating is having a good effect in extending the shelf life of the arils. Results obtained from the storage studies showed that coated arils, which packed in LDPE and PP in 5°C is having more shelf life. The arils kept in room temperature got only a life of 3 days and 4 days where as arils kept in 5°C is having 16 days and 20 days for PP and LDPE respectively. In both temperature studies the arils packed in LDPE gave more shelf life. Arils which have been coated with honey helps in increasing the shelf life up to 24 days packed in LDPE kept in 5°C. The safe storage temperature for arils is 4-5°C. Thick packaging material helps to reduce the gas transmission rate results in a reduction in respiration rate. So coating can act as a modified atmospheric technique during storage. When the coating of honey increases the aroma of arils is getting decreased.



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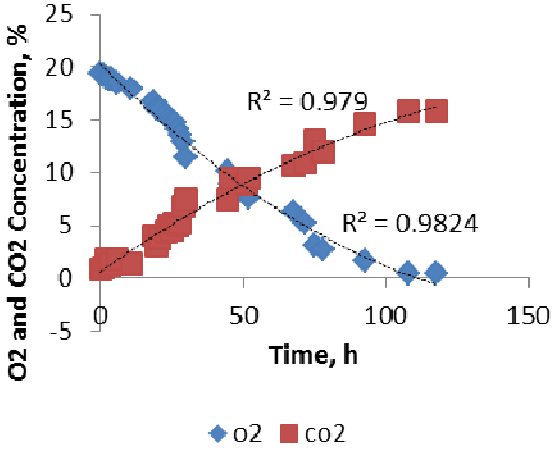

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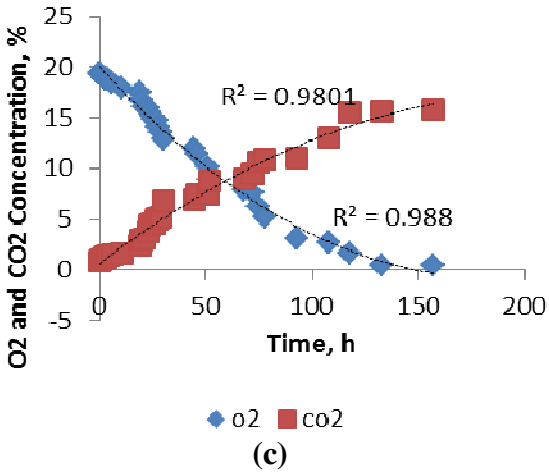

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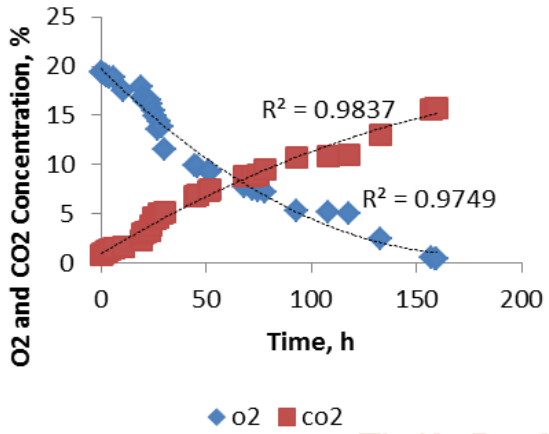

(d)

Figure 7: Oxygen and carbon di oxide concentration of (a) control, (b) 10% honey, (c) 20% honey and (d) 30% honey

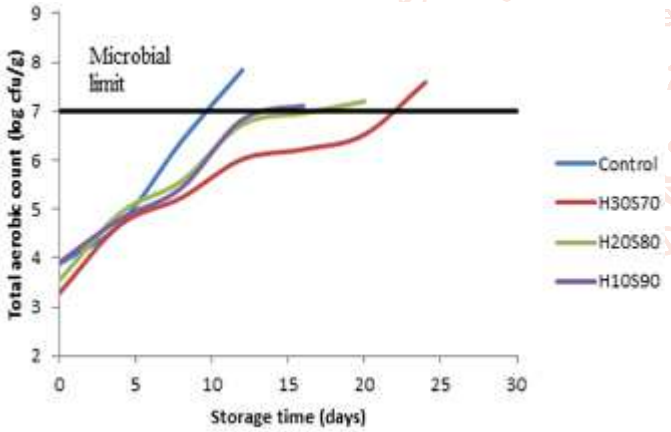

Fig. 8: Microbial count of various treatments and control sample

So the studies show that the maximum concentration of honey used can be 30%. The colour values were good for the less concentrated honey than high concentration. Soil aril ratio is less in less concentrated honey coating than high. Gas concentration studies also shows good results for low concentration coating. Microbial count got reduced according to the increase in the concentration of honey. In conclusion a low concentration (10%) of honey treatment give bright, rigid and an extension of the shelf life to the arils.

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